Automated Wallops Orbital Tracking Station

(AWOTS)

GENERIC REMOTE NODE

PRODUCT SPECIFICATION

Version 0.1

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D R A F T

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Automated Wallops Orbital Tracking Station (AWOTS) GENERIC REMOTE NODE PRODUCT SPECIFICATION

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Automated Wallops Orbital Tracking Station (AWOTS) GENERIC REMOTE NODE PRODUCT SPECIFICATION

1.0 INTRODUCTION

1.1 Identification of Document

This section identifies this physical document in terms of its relationship to the parent volume(s) in this documentation set.

This is the Product Specification (PS) for the Generic Remote Node (GRN) System under development for the Wallops Flight Facility (WFF) Automated Wallops Orbital Tracking Station (AWOTS). This document has been prepared according to the guidelines set forth in NASA-STD-2100-91. It supersedes the applicable portions of its parent documents.

1.2 Scope of Document

This section describes the area of cognizance, responsibility, and applicability for this document.

This PS applies to the GRN specific software developed for use by AWOTS. It is the responsibility of software developers in the Software Engineering Section, Code 822.4, of the Engineering Section, Code 822, at WFF to be cognizant of the contents of this document and to keep it current as software development and maintenance proceeds.

1.3 Purpose and Objectives of Document

This section describes the purpose and objectives for this document concisely and in specific terms.

The purpose of this PS is to document the technical aspects relative to the development of the GRN software. This information is produced over the life cycle for the software. It includes all aspects from requirements, through design and detailed description, to user, operations, and maintenance procedures, with the exception of the interface specifications.

1.4 Document Status and Schedule

This section describes the status, including goals and dates, for production or revision the document.

This PS will be a work in progress until the first release of the GRN is delivered. Currently the requirements and design are completed. Remaining sections will be written in conjunction with the actual software development at which time Version 1.0 will be published. Future versions will correspond to modifications of the GRN software.

1.5 Documentation Organization

This section describes the contents of each major section within this document and the contents of each appendix. It provides a documentation tree of all documents produced for the project showing the relationship between the documents, and where this document fits in that tree.

Section 2, Related Documentation, provides the references or bibliography for this document. Section 3, Concept, provides an overview of the software. Section 4, Requirements, specifies the functional, performance, and interface requirements of the software. Section 5, Architectural Design, documents the top-level comprehensive design for the software. Section 6, Detailed Design, describes the software in enough detail to be able to write the software code to implement the design. Section 7, Version Description, describes the configuration and content of the product. Section 8, User Documentation provides instructions to end users of the software. Section 9, Operational Procedures Manual, provides instructions to the system operators. Section 10, Maintenance Manual, provides a location for data and information to aid in analyzing and debugging the software. Section 11, Abbreviations and Acronyms, contains an alphabetized list of the definitions for abbreviations and acronyms used in this document. Section 12, Glossary, contains an alphabetized list of definitions for special terms used in the document. Section 13, Notes, presents information that aids in understanding the information provided in previous sections, and which is not contractually binding. Section 14, Appendices, contains material that is too bulky or detailed to be placed in the main body of text.

Documentation tree (refer to Section 2, Related Documentation, for full document names) :

OC&R

WOTS UPD

AWOTS DRNS

CRN CMP Master/GRN ICD

GRN PS

GRM PS

GDEVL PS

GCOML PS

GPPL PS

GCCS

2.0 RELATED DOCUMENTATION

The purpose of this section is to provide the references or bibliography for this document.

2.1 Parent Documents

The following documents are parent to this document:

Wallops Orbital Tracking Station (WOTS) Upgrade Process Operations Concept & Requirements for WOTS Master Subsystem & WOTS Remote Nodes Subsystem, Version 1.0, January 20, 1994. (OC&R)

Wallops Orbital Tracking Station (WOTS) Upgrade Process Design for WOTS Master Subsystem & WOTS Remote Nodes Subsystem, Version 0.1, June 24, 1994, Unpublished Draft. (UPD)

Automated Wallops Orbital Tracking Station (AWOTS) Design for Remote Node Subsytem, Version 1.0, June 12, 1995. (DRNS)

2.2 Applicable Documents

This section provides citations for all documents other than the parent which are referenced within this volume, or which are directly applicable, or which contain policies or other directive matters that are binding upon the content of this volume.

NASA Software Documentation Standard Software Engineering Program, NASA-STD-2100-91, July 29, 1991.

Manager's Handbook for Software Development, Revision 1, SEL-84-101, November, 1990.

Common Remote Node Configuration Management Plan, Proposed Version, 822-CRN-CMP-95, November 30, 1995. (CRN CMP)

Master/Generic Remote Node Interface Control Document, To Be Written (TBW). (Master/GRN ICD)

General C++ Coding Standards, TBW. (GCCS)

General Purpose C++ Library Product Specification, TBW. (GPPL PS)

General Communications Library Product Specification, TBW. (GCOML PS)

General Device Library Product Specification, TBW. (GDEVL PS)

General Resource Manager Product Specification, TBW. (GRM PS)

2.3 Information Documents

This section provides citations for documents which, although not directly applicable, amplify, or clarify the information presented in this volume.

Specific Device Library Product Specifications, TBW.

3.0 CONCEPT

The purpose of this section is to provide an overview of the software.

3.1 Definition of the Software

Throughout this presentation of the Concept, the term “user” refers both to humans and to interfacing software.

3.1.1 Purpose and Scope

This section briefly describes the purpose to be served by the software that is the subject of this Concept and the scope of its applicability. It describes the primary use(s) of the software within the context of the users’ environments.

The purpose of the GRN System is to provide low level control of a station's equipment. A GRN acts as a server, to a Master which is the client, providing access to the equipment resources. The primary uses of the software are to allow the Master to configure equipment for a satellite pass and to report the status of the equipment back to the Master during tracking operations.

3.1.2 Goals and Objectives

This section describes the goals and objectives for the software.

The general goals for tracking station automation are listed in Section 3.2 of the parent OC&R document. In keeping with the general goal of improved performance at a reduced cost, the goals of the GRN are to automate routine setup, checkout, and operation of equipment, to monitor the status of the equipment, and to report the status to a remote Master.

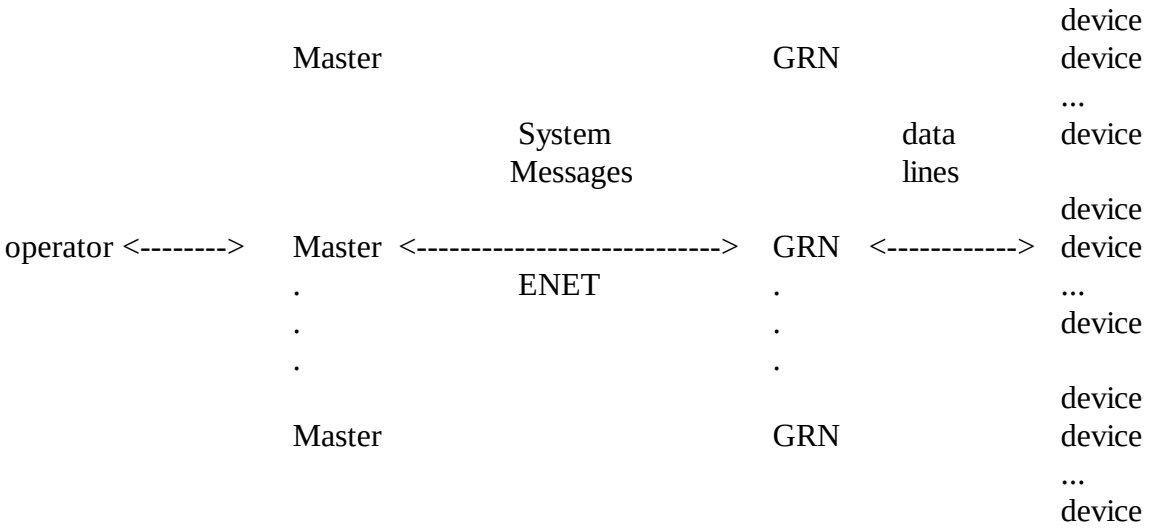
A secondary goal identified in Section 1.3 of the AWOTS DRNS document is the ability to reuse code. That objective is already being met by the GRN in that the same remote node software will be used on several of the AWOTS remote nodes.

3.1.3 Description

This section provides a top-level description of the software and its major external interfaces to provide a background to aid the reader in understanding what the software is to accomplish. It uses appropriate graphics, illustrations, tables, etc., to show functions and interrelationships.

The GRN software resides on one or more computers in a tracking station. The number of GRN computers needed is determined by the quantity and location of the equipment which must be controlled. A GRN is physically connected to the devices it controls by cables attached to its various I/O ports, the most common being serial RS-232, IEEE-488, and ISA bus cards. At this time, any devices which may be remotely controlled across an Ethernet (ENET) network are controlled directly by a Master.

A GRN is be connected by Ethernet network to one or more Master computers. If multiple Masters are present, only one may be in control of a specific group of equipment at any time. The other Masters may not issue commands, but are allowed to request status information for that equipment group.



3.1.4 Policies

This section lists or references the policies and standards governing the use and applicability of this software.

None have been identified at this time.

3.2 User Definition

This section lists and describes the expected users of the software, the way in which the users will be using the software, and the functional capabilities the users will require to perform their activities. It explicitly defines the users and their needs in terms and details that will make it possible to correlate system capabilities and characteristics to specific user needs.

A Master computer is the expected user of the software. Any user interfaces to devices are developed by Master software teams. However, user interface tasks may be run on the same computer as a GRN giving the appearance of local device control by the GRN to an operator. The GRN software obtains all of its commands and returns all of its responses through System Messages. It has no human operator interaction.

3.3 Capabilities and Characteristics

This section describes the major operational capabilities to be provided by the software. It identifies which users' needs are supported by each capability along with a table, matrix, or graphics if appropriate for clarity. It describes significant characteristics required of the software. It includes characteristics of the current and potential physical and organizational environment for the software. It discusses the general flow of both execution control and data across external interfaces for the software, including hardware and networking considerations affecting software operation. If there are major design constraints imposed upon the software, it identifies and describes each of them.

The GRN software is designed to provide the operational capabilities necessary to meet the requirements. The requirements are given in Section 4. The characteristics and design constraints are covered in Sections 5 and 6.

3.4 Sample Operational Scenarios

This section describes typical operational scenarios for the software. A scenario depicts at a high level how users (including other systems) interact with the capabilities provided by the software being defined. At least one scenario is included for each class or type of user. A scenario includes such matters as a description of an operation to be performed with support from the software and a description of the interaction between a user and the software in carrying out the operation.

Typical operation of a GRN takes place automatically from a remote Master computer system, which is the high level user. The Master sends the proper initialization files for support of a satellite pass. It commands the GRN to initialize its devices from those files and begin support. It specifies the rate for status reporting and expects to receive status and any error conditions. It terminates the support at the proper time.

The Master interacts with the capabilities provided by the GRN software through System Messages. System Messages and formats are defined and their use is described in the GCOML PS. The content of the messages is defined in the Master/GRN ICD.

In addition to the typical automated operation, a technician at the Master console may wish to create a device initialization file or obtain direct control of a device. Low level device control is a general device capability and is described in the General Device Library Product Specification. The description of the user interface and the definition of each available device command are located in the PS for each specific device.

4.0 REQUIREMENTS

The purpose of this section is to specify and augment, as appropriate, the functional, performance, and interface requirements of the software. The section also specifies the major characteristics, implementation constraints, and design goals. Each requirement should be uniquely identified to ensure traceability to the lowest level of implementation.

The original requirements for the GRN software are given in Section 5 of the parent OC&R.

4.1 Requirements Approach and Tradeoffs

This section describes the overall approach in gathering, analyzing, and synthesizing requirements, including use of prototyping techniques. It explains the tradeoff process used to analyze conflicting requirements and arrive at the actual specifications for those requirements.

The Remote Node requirements in the OC&R were divided into Interface Requirements (IR.1 - IR.2), Functional Requirements which include Support Requirements (SR.1 - SR.12), and Test Requirements (TR.1 - TR.2). The requirements for tracking station automation were determined after studying the WOTS manual mode of operation, observing operations, studying the equipment which was used, and interviewing operations personnel. The estimated CPU load and cable restrictions were factors in the decision to have separate Master and Remote Node computers. The use of separate computers created communications requirements between them.

4.2 External Interface Requirements

This section contains the specification of requirements for interfaces between this software and its external environment (i.e., all its users). This section may be rolled-out as a separate Interface Control Document.

The GRN software has external interfaces to a Master computer, and various devices. The Master interface requirements are defined in the Master/GRN ICD. Interface requirements for any device are defined in the PS for the device.

4.3 Requirements Specification

4.3.1 Process and Data Requirements

This section describes, as separately numbered items for traceability, the process and data requirements for the software in terms of functions and data.

The process requirements for the GRN are nearly identical to the AWOTS Remote Node requirements. Simply replace Remote Node with GRN. An additional requirement is the ability to configure equipment from an initialization file as directed by the Master. The requirement to initiate automatic recovery has been deleted.

The revised requirements are as follows:

R.1 - Communicate with the Master
The GRN will be able to communicate with the Master via an Ethernet interface.

R.2 - Communicate with resources
The GRN will be able to communicate with its resources. This is to be accomplished using dedicated interface cards, or RS-232 ports, or IEEE-488 ports.

R.3 - Configure equipment
The GRN will provide an interface to each type of equipment to be controlled by which the configuration can be set.

R.4 - Execute complete command set
The GRN will implement the complete command set for a resource.

R.5 - Monitor and report node status
The GRN will monitor the status of itself and report conditions to the Master.

R.6 - Monitor equipment status
The GRN will monitor the status of all its equipment.

R.7 - Report equipment status
The GRN will provide varying levels of status feedback to the Masters as requested.

R.8 - Report equipment availability
The GRN will provide the Master with information on equipment availability (i.e. 10 BrandX bit syncs).

R.9 - Detect equipment failure
The GRN will detect equipment failures and inform the Master.

R.10 - Respond to a general request
The GRN will respond to a request for a general resource (i.e. a BrandX bit sync).

R.11 - Respond to a specific request
The GRN will respond to a request for a specific resource (i.e. BrandX bit sync #5).

R.12 - Log status of support
The GRN will send logged status information to a Master for archiving and report generation.

R.13 - Initialize equipment
The GRN will provide for scripted control of each device from an initialization file by which the configuration can be set as directed by the Master.

R.14 - Perform diagnostic testing
The GRN will be able to conduct all levels of diagnostic tests, appropriate to the equipment it controls.

R.15 - Perform preventive maintenance
The GRN will be able to conduct all levels of preventive maintenance tests, including calibrations, appropriate to the equipment it controls.

4.3.2 Performance and Quality Engineering Requirements

This section specifies, as a separately numbered item for traceability, each performance requirement for the software in testable and quantitative terms. It includes timing and sizing requirements, sequence and timing of events, throughput and capacity requirements, error detection, isolation, and recovery requirements and quality engineering requirements.

P.1 - Process multiple supports simultaneously
The GRN must be able to able to set up and monitor resources for three supports simultaneously.

P.2 - Process multiple resources simultaneously
The GRN must be able to continuously process information from all of its resources simultaneously.

P.3 - Demonstrate reliability
The GRN software must run without operator interaction for up to xxx hours without failure.

4.3.3 Safety Requirements

This section specifies, as separately numbered items for traceability, the safety requirements for the software in a prioritized list. It includes potential contributions to system mishaps and user interface considerations from a human factors engineering viewpoint.

None have been identified at this time.

4.3.4 Security and Privacy Requirements

This section specifies, as separately numbered items for traceability, the security and privacy requirements for the software, including access limitations to the system, such as existence of log-on procedures and passwords, and of data protection and recovery methods. Each requirement is expressed in testable and quantitative terms and prioritized.

S.1 - Provide support security
The GRN will provide for warning messages and password protection before allowing changes to resources which are in use for a support.

S.2 - Provide file security
The GRN files will be password protected to prevent unauthorized access.

S.3 - Provide computer access security
The GRN computer platform will be password protected at the operating system level.

S.4 - Provide software configuration security

The GRN software will be created using Microsoft Source Safe to provide source code protection and will be maintained in accordance with the CMP.

4.3.5 Implementation Constraints

This section describes implementation constraints on the design and implementation of the software, such as the use of GFE, COTS, or use of specific compilers, etc. It includes existing software to be used or modified and lists or references engineering and technical standards to be applied in the development of the software.

I.1 - Hardware constraint

The GRN software will execute on an Intel Pentium based processor with an ISA bus.

I.2 - Operating system constraint

The GRN software will run under the Microsoft Windows NT operating system.

I.3 - Compiler constraint

The GRN software will be written and compiled with Microsoft Visual C++.

I.4 - Standards constraint

The GRN software will be written in ANSI standard C++ except for cases where compiler, operating system, or hardware constraints make it impossible.

4.3.6 Site Adaptation

This section specifies requirements for adapting the software to the physical environments within which it operates, including site-specific adaptation data or special parameters that are defined during installation.

A.1 - Adapt to resource configuration

The GRN will be adaptable to any resource hardware configuration based upon initialization information.

4.3.7 Design Goals

This section states the design goals for the software in terms of correctness, reliability, efficiency, maintainability, and technology transparency.

The primary goal of the GRN is to produce a correct and reliable working system within the assigned time frame. A secondary goal is to produce highly reusable software, thus increasing maintainability and development efficiency. Although the hardware platform, operating system, and compiler have already been identified, another goal is to achieve maximum technology

transparency by following ANSI standards and pushing system dependencies to the lowest level of software possible.

4.4 Traceability to Parent's Design

This section describes how these requirements map to the requirements allocated from the parent in tabular form.

These requirements	Parent requirements	These requirements	Parent requirements
R.1	**IR.1**	**P.1**	Section 5.3
R.2	**IR.2**	**P.2**	Section 5.3
R.3	**SR.1**	**P.3**	Section 5.3
R.4	**SR.2**		
R.5	**SR.3**	**S.1**	Section 5.5
R.6	**SR.4**	**S.2**	Section 5.5
R.7	**SR.5**	**S.3**	Section 5.5
R.8	**SR.6**	**S.4**	Section 5.5
R.9	**SR.7**		
-	**SR.8**	**I.1**	Section 5.6
R.10	**SR.9**	**I.2**	Section 5.6
R.11	**SR.10**	**I.3**	Section 5.6
R.12	**SR.11**	**I.4**	Section 5.6
R.13	**-**		
R.14	**TR.1**	**A.1**	**-**
R.15	**TR.2**		

4.5 Partitioning for Phased Delivery

If the software is to be developed in several stages for phased delivery, this section identifies the content of each delivery.

The GRN software will be developed in one stage and delivered in one phase as the AWOTS Recorder Node. Future releases will be planned for enhancements which have not yet been identified and error correction as needed. The remaining AWOTS Remote Node systems will be released as the necessary device drivers are developed, but changes to the GRN software itself are not anticipated in order to accomodate additional devices.

5.0 ARCHITECTURAL DESIGN

The purpose of this section is to document the top-level, comprehensive design for the software including major external and internal interfaces and logical data scheme. In addition it describes the rationale for the architecture.

5.1 Design Approach and Tradeoffs

This section describes the rationale and tradeoffs, and other design considerations, including any use of prototyping, influencing the major decisions affecting the design of the software.

The major design decisions for AWOTS software were made early in the upgrade process. It was decided to use Master computers for the user interaction which would communicate via an Ethernet network to a series of Remote Node computers or devices with Ethernet capability. System Messages using NT pipes would be developed for communication between processes on the Master and Remote Nodes, and for interprocess communication on a single AWOTS computer. The Remote Node computers would be used for direct communication to devices via serial ports, parallel ports, or ISA cards. The set of devices controlled by each Remote Node would be determined by the engineers based on such things as functional grouping, device characteristics, and physical location.

While the AWOTS concept called for several Remote Node computers, the Remote Node design team realized that one GRN software system could be used for all of them. To maximize reuse and decrease the potential for errors, an object oriented design approach was taken. Each device would be treated as an independent object with its own data members and and access functions. Each device would have its own controller process so that multiple devices could be accessed essentially simultaneously instead of sequentially. The idea of simultaneous access was especially important considering the physical response time of some of the devices or commands such as rewinding a tape. The device classes and associated processes are described in the GDEVL PS and GRM PS.

Prototyping was used to test NT operating system features such as threads, pipes, events, priorities, etc., and to confirm that they would function as needed in the design. For example, a System Message utility program was developed which was first used to test the design concepts, and later used to test actual interprocess communications. System Messages are described in the GCOML PS.

A prototype virtual device was developed which could be used to test the general level device classes. The prototyping helped to confirm the generality of the major portion of the design and the requirements for the supporting libraries and processes. Designs for support software are described in the GPPL, GDEVL, GCOML, and GRM Product Descriptions.

5.2 Architecture Design Description

The purpose of this section is to describe the logical or functional design of the software. It includes logical or functional decomposition, description of the lower level elements, relationships and interactions between lower level elements, logical data design, entity/data identification and relationships, timing and sequencing, and implementation constraints.

5.2.1 Design Overview

The GRN software has five distinct types of processes: message processing, resource management, device control, message logging, and user interaction. The processes each perform an individual task but working together satisfy the requirements of the GRN.

The Message Processor is the only process specific to AWOTS. The Message Processor process will receive system messages, typically from a Master, and handle them. The Message Processor will have two pipes for incoming messages, one with a high priority, and one with low priority. The high priority pipe will handle commands, while the low priority pipe will handle status requests.

The General Resource Manager process will have the responsibility for coordinating access to the devices on a GRN. A device registry file on each GRN will contain a list of attached devices and their port connections. The GRM will read this file to determine what devices are available and which drivers and ports to use. It will then service requests from callers to open and close the devices. The GRM design is contained in the GRM PS.

A separate Device Controller process will be started by the GRM for each device on the Node. A Device Controller process will receive System Messages containing device commands. Each embedded command will be extracted and passed to the device. When the device responds, the results will be packaged in a System Message and sent back to the requestor via the return address of the System Message. The design for a Device Controller process is contained in the GRM PS. System Message design is contained in the GCOML PS.

A Message Logger process will log system messages to an I/O stream such as a file. More than one Message Logger process may be run at a time. For example, one Message Logger may log all commands received from a Master, and another may log only error messages. The Message Logger design is contained in the GRM PS.

The User Interface process on the GRN will exist to provide the AWOTS user a fall back position in the event that the Master computer or the network system fails. It will allow the user to monitor the status of the node and directly control the equipment attached to that node. The GRN will reuse the User Interface processes developed on the Master for each device. Since interprocess communication is carried out through System Messages which include a return address, the location of the active User Interface will be transparent to the Message Processor and the Device Controller processes. The User The interface screens that will appear on a specific

Remote Node will a subset of those available and will be determined by the contents of the device registry file. User Interface design is contained in the AWOTS Master PS.

Figure 5.1 illustrates the interaction between the processes, a Master computer, and the physical devices.

Figure 5.1 GRN Processes

5.2.2 Message Processor

The only AWOTS specific process in the Remote Node subsystem, and therefore the only process to be detailed in this document, is the Message Processor. As such it may not be directly reused. However it can be used as a model for creation of similar processes on other projects. As its name implies, it processes system messages received from the Master or other processes on the Node.

The Message Processor has a high priority pipe and a low priority pipe. Messages on the high priority pipe are serviced before those on the low priority pipe. High priority messages consist of high level commands from the Master such as "Setup BrandX recorder #1 for support". Messages on the low priority pipe are serviced after those on the high priority pipe and consist of status requests such as "Report status for BrandY bit sync every 5 seconds".

The Message Processor consists of a high priority pipe server and a low priority pipe server. When a message is received on one of the pipes a thread is created to handle it. A new thread is created to handle each message. The thread determines how to handle the message by examining the system message category and type fields. If the category or type indicates that the message can not be handled by the GRN then the message is returned to the sender. If the message is acceptable then the appropriate functions are called to handle it.

As the supporting software development proceeded, and the specific AWOTS operational requirements were gathered, the design team recognized the use of a device related operations (Ops) class. The operations class was not made part of the GDEVL since the operations were defined as those required for AWOTS. The Message Processor receives requests to perform these operations, and passes them on to the proper devices. For each device, the following operations are required:

- General Resource Request
- Specific Resource Request
- Set Up
- Take Down
- Start Support
- Stop Support
- Start Status
- Stop Status
- Preventive Maintenance

The GRN Message Processor is able to handle messages for any of the equipment in the AWOTS station. The functions to handle the messages are dynamically loaded at the startup of the Message Processor based upon the type of equipment reported to be available by the GRM. This enables one set of GRN software to be installed on each Remote Node thus making the Remote Nodes interchangeable and easily replaceable in the event of a hardware failure.

5.2.3 Supporting Software

A number of general purpose software components were identified in the GRN design. These items were determined to not be AWOTS specific and have been designed to be available for direct reuse on other projects. These items, identified as Supporting Software, have been divided into three libraries and a resource managment process.

The General Purpose C++ Library contains ANSI standard C++ classes for common use such as string and time classes. In addition, a powerful error class has been developed. Instead of obtaining a traditional single integer value error return from a function call, the caller gains access to a linked list of error information. This information traces an error through the program's execution path to the lowest level where the error actually occurred. The error management scheme provides the line number and function name for each intermediate error and a human readable text description of the error. The GPPL PS contains a complete description of the available classes and their use.

The General Communications Library contains classes and functions which are highly operating system dependent such as interprocess communications and port I/O. Interprocess communications on either the same or different computers has been implemented through the use of System Messages modeled on a postal system. A message can be thought of as an envelope with a destination address, a return address, and a letter or other contents. While the contents of the envelopes may be AWOTS specific, the envelopes themselves are not.

In addition to classes for physical I/O ports, a soft port was also developed. The soft port uses a file to replace the actual device. It can be used to verify that commands are correct, to simulate a device when one is not available, and for recording and playback purposes. The GCOML PS contains a complete description of the available classes for use with System Messages and ports.

The General Device Library contains the layered device driver classes. Layered device drivers are being developed to interface to all of the equipment controllable by a GRN. The layers proceed from remote device command or local device control to driver to port. The functions available in the command and control layers appear identical to the applications programmer. However, the command layer sends and receives System Messages, while the control layer creates actual device instructions. The driver layer formats the instructions, and the port layer handles any operating system and hardware specific coding. The GDEVL PS contains a complete description of the available device and driver classes. The port class descriptions are contained in the GCOML PS.

The General Resource Manager uses all three libraries to manage access to the devices, and to create the Device controller processes and Error Logger processes on a GRN. An overview of these three processes was given in Section 5.2.1. Complete descriptions of the resource management processes are contained in the GRM PS.

5.3 External Interface Design

This section contains the design specifications for the interfaces between the software and its external users. This section may be rolled-out as a separate Interface Control Document.

The external interface design is contained in the Master/GRN ICD.

5.4 Requirements Allocation and Traceability

This section documents the allocation of the software's requirements to the lower level elements. It shows the traceability of all requirements including performance and constraints for this software to the design presented above.

R.1 - Communicate with the Master: Ethernet communication is fully supported under Windows NT and used by NT pipes across different computers. The GRN communicates with the Master via System Messages which use NT pipes.
R.2 - Communicate with resources: This requirement is handled by the GRM and associated libraries.
R.3 - Configure equipment: This requirement is handled by the Master developed user interface.
R.4 - Execute complete command set: This requirement is handled by the GDEVL and specific device library for each device.
R.5 - Monitor and report node status: TBD
R.6 - Monitor equipment status: This requirement is handled by the GRN Ops class, the GDEVL, and the specific device library for each device.
R.7 - Report equipment status: This requirement is handled by the GRN Ops class, the GDEVL, and the specific device library for each device.
R.8 - Report equipment availability: This requirement is handled by the GRN Message Processor and the GRM.
R.9 - Detect equipment failure: TBD for each device.
R.10 - Respond to a general request: This requirement is handled by the GRN Message Processor, the GRN Ops class, and the GRM and associated libraries.
R.11 - Respond to a specific request: This requirement is handled by the GRN Message Processor, the GRN Ops class, and the GRM and associated libraries.
R.12 - Log status of support: This requirement is handled by the GRN Message Processor and the GRM message logger.
R.13 - Initialize equipment: This requirement is handled by the GDEVL and specific device library for each device.
R.14 - Perform diagnostic testing: This requirement is handled by utility programs TBD for each device.
R.15 - Perform preventive maintenance: This requirement is handled by utility programs TBD for each device.

P.1 - Process multiple supports simultaneously: The selection of Windows NT allows for multiple independent supports. The GRM will prevent attempts by different supports to use the same equipment simultaneously.
P.2 - Process multiple resources simultaneously: The selection of Windows NT allows for multiple independent supports. The number of simultaneous resources is limited only by such factors as the number of I/O ports which can be added to a single processor, the amount and rate of information to be processed for each device, and the available memory and processor speed of the CPU.
P.3 - Demonstrate reliability: The GRN will be tested for the required time in parallel with the existing manual support mode to demonstrate its reliability prior to operational use.
S.1 - Provide support security: Authorized access TBD.
S.2 - Provide file security: Authorized access TBD.
S.3 - Provide computer access security: This requirement is handled by the NT systems administrator.
S.4 - Provide software configuration security: Microsoft Source Safe has been purchased and will be used when the first version is ready to be released.
I.1 - Hardware constraint: GRN software team members were provided with Intel Pentium based computers with an ISA bus to ensure that the software they developed will run properly on the target computers.
I.2 - Operating system constraint: Windows NT was installed on the computers used by the GRN software team members to ensure that the software they developed will run properly under the target operating system.
I.3 - Compiler constraint: Visual C++ was installed on the computers for the compiler to be used by the GRN software team members.
I.4 - Standards constraint: Compiler, operating system, and hardware specific code has been pushed to the lowest level in the various libraries allowing the GRN software to be completely written in ANSI standard C++.
A.1 - Adapt to resource configuration: This requirement is handled by the GRM.

5.5 Partitioning for Incremental Development

If the software is to be produced using phased delivery or incremental development, this section specifies what requirements and functions are to be satisfied in each increment of the software.

The GRN software will be delivered in one phase which satisfies all the requirements listed in Version 1.0 of the PS. Development, however, may be considered incremental in that the supporting libraries and processes must be completed first, and that specific Remote Nodes will be released as the necessary device classes are completed. The Recorder Node is scheduled to be first and will be contain the GRN software.

6.0 DETAILED DESIGN

The purpose of this section is to describe the design for the software in enough detail to be able to write the software code to implement the design. It defines the structure and functions down to the computer software unit level.

6.1 Detailed Design Approach and Tradeoffs

This section describes the rationale and tradeoffs, and other design considerations, including any use of prototyping, influencing the major decisions affecting the design of the software.

The design approach remained the same as for the architectural design.

6.2 Detailed Design Description

The overall design for the Message Processor remained the same as described in the architectural design.

6.2.1 Compilation Unit Design and Traceability to Architectural Design - TBW

This section presents the overall physical design of the software into its compilation units. It includes information about each unit and a mapping of or the traceability between the architectural design elements to the compilation units.

Note: For each unit include:
Identification
Inputs and outputs
Functions
Data descriptions and relationships
Diagrams
Control and signal flow
Error Handling
Interface descriptions between compilation units
Packaging details such as placement of units in library

6.2.2 Detailed Design of Compilation Units - TBW

This section contains the design information detailed to the level necessary to code the individual compilation units and all lower level code units.

Note: For each unit include:
Detailed design to the lowest level
Functions or operations
Algorithms
Specific data definitions including data conversions
Local and global data
Parameters for initiation and adaptation
Logic flow including control flow, timing variations, priority assignments, and interrupt priorities and handling
Error detection and handling
Physical data design including internal schema, query language, access method, key, record, and data element definition and structure, and use of database management capability
Device interface

6.3 External Interface Detailed Design

This section contains the design specifications for the interfaces between the software and its external users. This section may be rolled-out as a separate Interface Control Document.

The external interface design is contained in the Master/GRN ICD.

6.4 Coding and Implementation Notes - TBW

The purpose of this section is to specify information such as stubs for incremental development and use of compiler options.

6.5 Firmware Support

NA. The software design is not implemented in firmware.

7.0 VERSION DESCRIPTION - TBW

This section describes in detail the configuration and content of the product. For each new release, the section provides information on the status of changes since previous releases.

7.1 Product Description

This section provides a description of this version of the product and uses references to the appropriate sections of the requirements or design sections.

7.2 Inventory and Software Product Identification

7.2.1 Materials Released

This section lists physical materials delivered with the version including all media containing code, documentation, utility and support software, and required hardware.

7.2.2 Product Content

This section identifies the exact configuration of the product delivered by this version. It includes the location of the source and object code for this version and specifies the compiler and, if applicable, the assembler, and version of each, used to generate the executable from the source code.

7.3 Change Status

This section describes the capabilities newly installed in this version and any changes to capabilities provided by the previous version. It identifies any requirements that are known to be unsupported.

7.3.1 Installed Changes

This section lists, by identifier and title, the changes approved by the CCB that have been newly incorporated in this version, and identifies the RFS associated with each change.

7.4.2 Waivers

This section lists all waivers that have been approved for this version and summarizes their effects on the version's functional capabilities or operation.

7.4.3 Possible Problems and Known Errors

This section identifies and describes the operational effects of each possible problem and known error in the version, together with steps being taken to resolve them and ways for working around them.

8.0 USER DOCUMENTATION - TBW

8.1 User's Guide

The purpose of this section is to provide instructions to end users (human and other systems rather than system operators or administrators) on the use of the software.

8.1.1 Overview of Purpose and Functions

This section describes the purpose and main capabilities of the software, and states its overall operation in terms of functions, options, and restrictions and limitations. If appropriate, it references the version description section.

8.1.2 Installation and Initialization

This section explains in detail the procedures for installing, tailoring, and initiating the software. It includes equipment set-up, power-on and power-off, bootstrap and load, initiation commands, interrupt/recovery/restart, initialization of files, variables, or other data, tailoring, reconfiguration, adaptation, and reinitialization after failure.

8.1.3 Startup and Termination

This section describes how to start and terminate operation normally, and how to determine whether normal termination has occurred. If the user has some control over abnormal termination, it describes the procedures involved. It describes procedures for restarting after both normal and abnormal termination. If recovery procedures are required for restarting after abnormal termination, they are explained in section 8.1.6.

8.1.4 Functions and Their Operation

This section describes each function in terms of its purpose, procedures for execution, user inputs, expected results and procedures for examining these results, and related functions. It describes any inputs from a source other than the user that may occur while the software is in use and that may affect its interface with the user. It includes applicable attributes of the input such as format, frequency, and effect upon the software state or mode.

8.1.5 Error and Warning Messages

This section lists and explains each possible error condition and associated message that may be encountered. It describes the corresponding corrective actions to be taken and identifies an agency that may be called upon for assistance.

8.1.6 Recovery Steps

This section explains recovery procedures the user may employ.

8.2 User's Training Materials

The purpose of this section is to document the training materials provided for the users.

9.0 OPERATIONAL PROCEDURES MANUAL - TBW

The purpose of the section is to provide instructions to the system operators (as opposed to end users) on the procedures for operation, controlling, troubleshooting, and maintaining the software.

9.1 System Preparation and Set-Up Procedures

This section describes the procedures conducted by the operator to set-up and prepare the system for operation, both initially and for new releases or modifications to the system. This includes instructions for both software and, as appropriate, hardware.

9.2 Standard Operation Procedures

This section describes the detailed operational procedures that are part of the standard practices for operating the information system. The types of procedures defined here include monitoring procedures, daily operating procedures such as system back-ups and logs for maintenance, standard safety and security procedures, and on-demand procedures such as in response to a user request.

9.3 Fault and Recovery Procedures

This section describes the detailed operational procedures to be conducted in case of a fault or abnormal condition in the hardware, software, or some other aspect of the system. The immediate actions and subsequent recovery procedures are documented of every anticipated fault condition.

9.4 Emergency Procedures

This section describes the detailed operational procedures to be conducted in case of an emergency. The types of procedures defined here include procedures for critical system failures, environmental emergency procedures such as fires or hurricanes, and safety or security emergency procedures.

9.5 Diagnostic Procedures

This section explains diagnostic procedures the operator may employ such as correlation to error messages, diagnostic initialization, recording diagnostic data, and analysis of diagnostic results.

10.0 MAINTENANCE MANUAL - TBW

The purpose of this section is to provide a location for data and information to aid in analyzing and debugging the software. It should not duplicate information available in other sections.

10.1 Implementation Details

This section describes details about specific data representations or formats, operating system interfaces and dependencies, support software such as libraries, hardware dependencies, and other interfaces.

10.2 Modification Aids

This section describes design details that could be used in the modification or expansion of the software.

10.3 Code Adaptation

This section describes design details that support the initialization or adaptation of data or code. This information is related to the version information of the software.

11.0 ABBREVIATIONS AND ACRONYMS

This section contains an alphabetized list of the definitions for abbreviations and acronyms used in this document.

AGNS	Automated Ground Network System
AWOTS	Automated Wallops Orbital Tracking Station
CCB	Configuration Control Board
CMP	Configuration Management Plan
COTS	Commercial Off the Shelf
CPU	Central Processing Unit
CRN	Common Remote Node
DRNS	Design for Remote Node Subsystem
ENET	Ethernet
GCCS	General C++ Coding Standards
GRN	Generic Remote Node
GCOML	General Communications Library
GDEVL	General Device Library
GFE	Government Furnished Equipment
GPPL	General Purpose C++ Library
GRM	General Resource Manager
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
I/O	Input/Output
MBR	Mila Bermuda Reengineering
NA	Not Applicable
NASA	National Aeronautics and Space Administration
OC&R	Operations Concept & Requirements
PS	Product Specification
TBD	To Be Determined
TBW	To Be Written
UPD	Upgrade Process Design
WFF	Wallops Flight Facility
WOTS	Wallops Orbital Tracking Station

12.0 GLOSSARY

This section contains an alphabetized list of definitions for special terms used in the document in a sense that differs from or is more specific than the common usage for such terms.

None.

13.0 NOTES

This section presents information that aids in understanding the information provided in previous sections, and which is not contractually binding.

None.

14.0 APPENDICES

The appendices contain material that is too bulky or detailed to be placed in the main body of text. They are referred to in the main body of the text where the information applies.